ARMY RESEARCH LABORATORY

Meteorological/Sensor Optimization Urban Summary and Model Survey

by Manuel D. Bustillos, Gail T. Vaucher, Robert O. Brice, and Ron Cionco

ARL-TR-4572 September 2008

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Army Research Laboratory
White Sands Missile Range, NM 88002

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Computational and Information Sciences Directorate, ARL

REPORT DOCUMENTATION PAGE	*Form Approved OMB No. 0704-0188*

1. REPORT DATE *(DD-MM-YYYY)*	**2. REPORT TYPE**	**3. DATES COVERED (From - To)**
September 2008	Final	

4. TITLE AND SUBTITLE	
Meteorological/Sensor Optimization Urban Summary and Model Survey	**5a. CONTRACT NUMBER**
	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	**5d. PROJECT NUMBER**
Manuel D. Bustillos, Gail T. Vaucher, Robert O. Brice, and Ron Cionco	**5e. TASK NUMBER**
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)	**8. PERFORMING ORGANIZATION REPORT NUMBER**
U.S. Army Research Laboratory Computational and Information Sciences Directorate Battlefield Environment Division (ATTN: AMSRD ARL CI ED) White Sands Missile Range, NM 88002-5501	ARL-TR-4572
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	**10. SPONSOR/MONITOR'S ACRONYM(S)**
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT

This report provides an introduction and survey of a proposed resource that offers an Army-relevant review of models as well as an assessment of models for future U.S. Army Research Laboratory (ARL) *Urban Studies*. The resource documentation establishes a number of models available from military and government agencies, colleagues, open literature, product reviews, technical reports, and Web sites, and provides a description of valuable factors, including sensors, measurement rates, analog and digital inputs and outputs, as well as some insight into how the models were prepared. It also provides a focus on urban topics, model availability to ARL's Battlefield Environment division, and the ARL cross-branch collaboration in order to give researchers quick access to reviews of an assortment of models with general and specific characteristics without the complexity of having to sort through information on the Internet. It also include a survey of urban models with another size of footprint (spatial) models. The resource is available in two 3-ring loose-leaf binders or on a CD, either of which can be requested by ARL and non-ARL researchers. By using this resource, researchers will be able to identify the model of their choice and then take action to form their need.

15. SUBJECT TERMS

Urban Models, Model Survey, Meteorological Models, General and Specific Characteristics For Models

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			Manuel D. Bustillos
U	U	U	SAR	26	**19b. TELEPHONE NUMBER** *(Include area code)* (575) 678-2987

Standard Form 298 (Rev. 8/98)
Prescribed by ANSI Std. Z39.18

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Acknowledgments

Appreciation is extended to the U.S. Army Research Laboratory (ARL), Battlefield Environment (BE) Division's Atmospheric Modeling Applications Branch and Atmospheric Dynamics Branch at White Sands Missile Range, NM. The participating branch members include Dr. Don Hoock and Robert Brown.

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Summary

The purpose of the report is to introduce and outline a proposed resource that provides a survey of an Army-relevant review of models as well as an assessment of models for future U.S. Army Research Laboratory (ARL) *Urban Studies*. The resource documentation establishes a number of models available from military and government agencies, colleagues, open literature, product reviews, technical reports, and Web sites. The resource provides a description of valuable factors, including sensors, measurement rates, analog and digital inputs and outputs, as well as some insight into how the models were prepared. It also provides a focus on urban topics, model availability to ARL's Battlefield Environment (BE) Division, and ARL's cross-branch collaboration interests in order to give researchers quick access to reviews of an assortment of models with general and specific characteristics without the complexity of having to sort through information found on the Internet. Also it offers a survey of urban models with another size of footprint (spatial) models. Furthermore, in order to aid data acquisition for modeling, the resource presents its information in two formats, as two 3-ring loose-leaf binders or on a CD, either of which can be requested by ARL and non-ARL researchers.

The review of models and the models assessments in this resource will provide the descriptive effects of each model, which will help to identify important attributes. Using this resource, researchers will be able to identify the model of their choice and then take action to form their need.

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1. Introduction

This report contains an introduction and outline of a proposed resource that provides a survey of an Army-relevant review of models as well as an assessment of those models. The number of models available for the survey exceeded those tabulated. Survey resources include military and government agencies, colleagues, open literature, product reviews, technical reports, and Web sites. To address ARL's priority to better serve the U.S. Army's interests, this resource documentation focuses on urban topics, model availability to ARL's BE, and ARL's cross-branch collaboration interests. The second objective of the project is to give researchers a quick access document that provides reviews and assessments of an assortment of models with general and specific characteristics, saving researchers the complexity of having to sort through information on the Internet. In the process of surveying the urban models, we encountered another size of footprint (spatial) models, which have been included. The resource is available in two formats, two 3-ring loose-leaf binders and a CD, either of which can be requested by ARL researchers, their colleagues, the military, and government agencies. The contents will include a review of models and model assessments, providing only the descriptive effects of each model. Such information will help to identify important model attributes, thus allowing researchers to identify the model(s) that will meet their needs.

2. Models Resolution (Spatial)

Model resolution is important to the modeler/researcher. In this survey the two important horizontal scales were microscale (2 m to 2 km) and mesoscale (2 km to 2000 km).[1] These factors determine the scales of horizontal motion, which, in turn, limits and/or determines the size of the program. This resource will make such information available to modelers/researchers who are interested in either of the scales or in other factors such as macro and viscous. The idea is to put these tools in researchers' hands so that they can compare side by side which model would serve their objective best.

[1]Stull, R. B. *Meteorology for Scientists and Engineers Second Edition*, Brooks/Cole: Florence, KY, 2000, table 10-1, p 205.

3. How to Use These Tool/Reference

The model documents consist of *The July 2004 Abbreviated Reviews of 100 Models, Simulations, and Games for Domestic Preparedness Training and Exercising* by Rebecca Agrait Andrew English, David J. Evans, Thomas J. Hammell, Julia J. Loughran, and Marchelle M. Stahl, which was prepared for the Office for Domestic Preparedness Department of Homeland Security. The first part of this library is in a 3-ring loose-leaf binder that contains 100 model reference sheet summaries in alphabetical order. A second 3-ring loose-leaf binder contains an alphabetized list of the assessments of the models provided by the Office of the Federal Coordinator for Meteorological Services and Supporting Research (OFCM) FCM-13-1999 March.

Each binder provides information on one product: one binder offers a review with important description and the other binder describes the models attributes, functions, scale, model certification, and other requirements.

Both binders can be obtained from the in-house library at the north end of building 1622 at White Sands Missile Range (WSMR), NM. Researchers can borrow either or both binders or the CD as well as look through the binders in-house. Researchers outside of ARL WSMR will need to contact an ARL colleague who will sign out the material as needed. For ARL researchers at other facilities or sites, the material can be mailed.

This resource is in support of Innovative Technology Application's (ITA) prime contract[2] with Office for Domestic Preparedness, Department of Homeland Security[3].

4. Model System Requirements

When using the binder version of this resource, users are required to keep the reference summary documents in the same alphabetical order in which they were found. This is required so that future researchers will also be able to use the resources effectively to search for their model summaries of choice.

Files on the CD version of the resource are available in two different formats: PDF and Microsoft Word.

[2] ThoughtLink, Inc., 2009 Cantata Court, Vienna VA 22182, (703) 281-5694, www.thoughtlink.com, 2004. Under contract GS-35F-012K/OJP-2002-BF-016, Office for Domestic Preparedness, Department of Homeland Security.

[3] Office of the Federal Coordinator for Meteorological Services and Supporting Research (OFCM) FCM-13-1999 *March Directory of Atmospheric Transport And Diffusion Consequence Assessment Models* U.S. Department of Commerce/National Oceanic and Atmospheric Administration: Washington, DC March 1999.

When using the resource, researchers should pay particular attention to the contact information, version, and date of evaluation, and reference the appropriate credits. If a researcher finds a reference that is outdated and can provide a more up-to-date reference, that person should add a dated copy of the new finding to the collection.

Once a researcher has identified a model needed, the researcher may have the option of downloading that model. If that is the case, the researcher will need to fill out a request document with ARL. Note: Where applicable, the resource will list a Web site/e-mail address where researchers can go to download the model to their PC at their convenience. The Web site or POC will provide a list of the PC requirements and/or tools needed to download and work with their model of choice.

5. Model by Function

In our experience, when researchers or modelers need a model, they start by looking on the Internet. Doing this is productive but can be very time consuming. This resource was created to save that time and effort by providing a 3-hole loose-leaf binder hard copy and CD that describes each model's functions. By assembling this information via this method, we have cut research time by 50%. By accessing the resource, researchers can determine which models possess the functions they require. Both the versions of the resource (hard copy and CD) describe the following general specific functions/characteristics:

- model capabilities
- lifecycle
- last custodian or point of contact
- sponsor or developing organization
- model description summary
- application limitation
- strengths and limitations
- model references
- input data requirements
- an output summary
- applications
- user friendliness

- hardware/software requirements
- operation parameters
- quality assurance documentation
- other submodel types
- health consequence submodel types
- effects and countermeasures submodel types
- physical features of the model
- model input requirements
- model capabilities
- model usage consideration

All models have application limitations. Some models provide only vertical releases, others have only performed in classrooms, and some models may not meet current needs. Thus, the function of a model must be evaluated for its utility and applicability. Figures 1 and 2 present two good reviews of model samples. Figure 3 displays the one good assessment of a single dispersion of accidental releases model. Table 1 shows urban models and table 2 summarizes general models.

<table>
<tr><td colspan="2">Product Name: ADASHI First Response Automated Decision Aid System for Hazardous Incidents (ADFR)</td></tr>
<tr><td>Company:
Optimetrics, Inc.
2107 Laurel Bush Rd., Suite 209
Bel Air, MD 21015
Web site: www.ADASHI.org</td><td>Contact Info:
Alex M. Menkes, Program Manager
Optimetrics, Inc.
2107 Laurel Bush Rd, Suite 209
Bel Air, MD 21015
amenkes@ADASHI.org</td></tr>
<tr><td colspan="2">Key Product Attributes:</td></tr>
<tr><td>Product Type: Dynamic Media (Consequence Assessment Model)
Commercial or Government Owned: CO
Media Scale: Individual
Application Environment: Exercise, Operational, Analysis</td><td>Training Type it Supports: Possibly Awareness, Part-Task Training, Pre-Training, TTX, FE
Functional Area(s) it Supports: EMS, EMA, Fire, Government Administrator, HazMat, Law Enforcement
Primary Target Audience: First Responders, Commanders, Local Officials, State Officials</td></tr>
<tr><td colspan="2">Product Description:
ADASHI First Response is a stand-alone, off-the-shelf HAZMAT and terrorism incident public safety decision aid for first responders. The program is founded on well-known tools such as CAMEO and ERG 2000 and includes a sophisticated interface design to allow manual-free and training-free operations during life-threatening hazardous incidents. The software provides emergency responders, decision makers, and support personnel with a user-friendly, intelligent PC-based tool to plan, mitigate, and track both large scale and daily hazardous incidents.
Advantageous MS&G Features: Requires Active User Decision Making; Simulation Support</td></tr>
<tr><td colspan="2">Version: 1.0
Date evaluated: August 28, 2003</td></tr>
</table>

Figure 1. Abbreviated review of models showing the Automated Decision Aid for Hazardous Incidents (ADASHI) First Response model, version 1.0.

Product Name: ADASHI Professional Automated Decision Aid System for Hazardous Incidents (ADPR)	
Company: Optimetrics, Inc. 2107 Laurel Bush Rd., Suite 209 Bel Air, MD 21015 **Web site**: www.ADASHI.org	**Contact Info:** Alex M. Menkes, Program Manager Optimetrics, Inc. 2107 Laurel Bush Rd, Suite 209 Bel Air, MD 21015 amenkes@ADASHI.org
Key Product Attributes:	
Product Type: Operational System (Incident Response) **Commercial or Government Owned:** CO **Media Scale:** Small Multi-User Team, Large Multi-User Team **Application Environment:** Training, Exercise, Operational, Analysis	**Training Type it Supports:** Awareness, Part-Task, Drills, TTX, FE, FSE, and Distributed Collaborative Exercise **Functional Area(s) it Supports:** EMS, EMA, Fire, HazMat, Public Safety Communication **Primary Target Audience:** First Responders, Commanders, Local Officials, State Officials, Federal Officials
Product Description: The Automated Decision Aid System for Hazardous Incidents (ADASHI) product line provides civil authorities responding to chemical, biological, radiological, nuclear, or explosive (CBRNE) events with an "over the shoulder" decision-support system to assist incident commanders in making better, timelier decisions by rapidly processing the multivariate input data and providing critical information in high-stress environments. ADASHI effectively integrates the specific technical functions required to mitigate both an everyday HAZMAT incident and an infrequent WMD event. The product features include hazardous agent identification, source analysis, physical protection of responders, decontamination, medical treatment, casualty care, resource and equipment monitoring/tracking, multi-tier communication, scenario-based planning and training, and EOC command and control displays. **Advantageous MS&G Features:** Records User-Specific Performance; Requires Active User Decision Making; Automated Recording of Learner Unit Information Sharing; Simulation Support; Remote Observation; Enhanced Communication T&E; Part-Task Training	
Version: Under development **Date evaluated:** August 28, 2003	

Figure 2. Abbreviated review of models showing the ADASHI Professional model, which is under development.

General and Specific Characteristics for Model: **ADAM**

General Characteristics		
1	**Abstract of Model Capabilities**	The Air Force Dispersion Assessment Model (ADAM) was developed so that the U.S. Air Force could calculate the source emissions rate and transport and dispersion of accidental releases of eight specific chemicals: Chlorine, fluorine, nitrogen tetroxide, hydrogen sulfide, hydrogen fluoride, sulfur dioxide, phosgene, and ammonia. Release scenarios include continuous and instantaneous, area and point, pressurized and unpressurized, and liquid/vapor/two-phase options. Dispersion is calculated for ground-based jets or for ground-level area sources for neutrally buoyant and negatively buoyant clouds. The model accounts for chemical reactions and phase changes.
2	**Sponsor and/or Developing Organization**	AL/EQS, Tyndall AFB, FL TMS, Burlington, MA
3	**Last Custodian/ Point of Contact**	Sponsor AL/EQS 139 Barnes Drive Tyndall AFB, FL 32403-5319 (904) 283-6002 Developer Dr. Phani Raj, TMS, Inc., 99 South Bedford St., Suite 211 Burlington, MA 01803-5128 (617) 272-3033 The source code and executable programs for ADAM can be accessed on EPA's SCRAM Web Site at http://www.epa.gov/scram0001/. (executable file is adam.zip, 277Kb, zipped).
4	**Life-Cycle**	ADAM was first developed for the USAF by TMS in the mid-1980s. In the late 1980s, the model was expanded so that it would better handle HF and fluorine. In 1991–1992, the USAF technical project monitor, Bruce Kunkel, debugged the code and modified some sections so that it would be more robust, and carried out many sensitivity studies.
5	**Model Description Summary**	ADAM is the most comprehensive of the publicly available models, in the sense that it treats a wide spectrum of source emission conditions (e.g., pressurized tank ruptures, liquid spills, liquid/vapor/two-phase) and also treats a variety of dispersion conditions (e.g., ground-based jets or ground-level area sources, all types of relative cloud densities, chemical reactions and phase changes, dense gas slumping). The code is restricted to eight chemicals of interest to the USAF. The formulas have been designed so that ADAM reduces to AFTOX for neutrally dense (i.e., passive) clouds.
6	**Application Limitation**	ADAM is limited to eight chemicals (see number 1) and cannot be used for other chemicals without modifying the source code. For a horizontal jet release, the model always assumes that the jet is ground-based, even though the user needs to provide the jet elevation information. ADAM does not treat the vertical component of the jet trajectory.
7	**Strengths/ Limitations**	**Strengths:** ADAM treats a wide variety of source conditions and accounts for the effects of dense gases, chemical reactions, and latent heat exchanges. It reduces to AFTOX for non-buoyant clouds. **Limitations:** ADAM can be applied to only eight chemicals. The 1990 version had many bugs, although Kunkel (1992) has corrected the bugs as part of his evaluations and sensitivity studies.
8	**Model References**	! Raj, P.K. and J.A. Morris, 1987: Source Characterization and Heavy Gas Dispersion Models for Reactive Chemicals. AFGL-TR-88-0003(I), AFGL/AFSC, USAF, Hanscom AFB, MA 01731-5000. ! Raj, P. K., 1990: Hydrogen Fluoride and Fluorine Dispersion Models Integration into ADAM. GL-TR-90-0321(I), GL/AFSC, USAF, Hanscom AFB, MA 01731-5000. ! Mullett, C. and P.K. Raj, 1990: A User's Manual for ADAM. GL-TR-90-0321(II). GL/AFSC, USAF, Hanscom AFB, MA 01731-5000. ! Kunkel, B.A., 1992: A Review and Evaluation of the ADAM 2.1 Dispersion Model. PL-TR-92-2245. PL/DG/AFMC, USAF, Hanscom AFB, MA 01731-5000.

Figure 3. Example of assessment models showing the Air Force Dispersion Assessment model (ADAM).

General and Specific Characteristics for Model: **ADAM**

9	**Input Data/Parameter Requirements**	In order to make a model run, the user must specify chemical information, release information, ground conditions, atmospheric conditions, release site and time information, and output options. ADAM treats only eight chemicals, namely ammonia, chlorine, fluorine, hydrogen sulfide, hydrogen fluoride, nitrogen tetroxide, phosgene, and sulfur dioxide. Properties of those chemicals are stored in a database and therefore need not be provided by the user. The user can either directly specify the source strength, or instruct ADAM to calculate the source strength based on information such as pipe diameter, pipe length, and storage pressure. By default, ADAM determines atmospheric stability using Golder's nomogram, based on the surface roughness specified by the user and the Monin-Obukhov length internally calculated by the model. If the standard deviation of wind direction is known and is provided as an input, ADAM will use it to determine atmospheric stability. The user has the option of providing an additional data file containing wind direction (but not wind speed) as a function of time in order to simulate the effects of variable wind direction. Up to 100 data points for wind direction can be entered. ADAM does not impose any limit on the time resolution for these time-varying wind direction data. However, it is recommended that the time interval between successive wind directions should be around 10 minutes or longer, since the effect of varying wind directions over a shorter time period has been parameterized through the lateral dispersion coefficient, s_y.
10	**Output Summary**	In addition to displaying a contour plot of the results for a default concentration value assumed by the model on the computer screen (but which can be changed by the user if necessary), ADAM also creates a summary output file which includes downwind distributions of the maximum predicted concentration, the cloud width, the cloud travel time, and the cloud advective speed. The information used to create contour plots on the screen is also saved in a separate output file, so that the plots can be regenerated at a later time.
11	**Applications**	See the references under number 8 for examples of applications and evaluations with field data. Also see Hanna et al. (1991), for evaluations of ADAM and 13 other models with the Goldfish hydrogen fluoride field tests and the Desert Tortoise ammonia field tests.
12	**User-Friendliness**	The ADAM model has a graphical user interface (GUI). The user moves through a series of menus or panels to define the scenario. After calculations are completed, the model then displays a contour plot on the computer screen. The plot shows the area where predicted concentrations exceed a toxic limit.
13	**Hardware-Software Interface Constraints/ Requirements**	**Computer operating system:** The model runs in the MS-DOS environment, PC (486 or better). **Computer platform:** **Disk space requirements:** It requires at least 2.5 megabytes of disk space. **Run execution time** (for a typical problem): **Programming language:** The computational part of the ADAM model is written in standard FORTRAN. The graphical user interface is written in FORTRAN, but with calls to the proprietary HISCREEN graphics library routines, which are specific to the FORTRAN compiler and computer hardware. **Other computer peripheral information:**
14	**Operational Parameters**	**Identify whether the code has any error diagnostic messages to assist the user in troubleshooting operational problems:** The ADAM model validates the input parameters that the user specifies through the GUI. A value that is out of range will be flagged and the user is requested to enter that value again. The model has limited run-time error diagnostics. **Set up time for:** Requires only minimal set-up time. After the model files are copied onto a computer's hard disk, the user needs to specify the type of display monitor and printer. Batch mode Capability (several cases at once). Due to its graphical user interface (GUI), the ADAM model cannot be run in batch mode, at least not in straightforward manner.
15	**Surety Considerations**	**All quality assurance documentation:** The ADAM model has been reviewed by the U.S. Air Force (Kunkel 1992). The model is known to converge to the U.S. Air Force's AFTOX model for passive releases. **Benchmark runs:** See Kunkel (1992) for comparisons with AFTOX, and Hanna et al. (1991) for comparisons with 13 other models. **Validation calculations:** **Verification with field experiments that has been performed with respect to this code:** The original references include many examples of comparisons with field experiments (see number 8 above). The paper by Hanna et al. (1991) evaluates ADAM with the Desert Tortoise ammonia and the Goldfish hydrogen fluoride field experiments. Performance is reasonably good in all case, showing agreement with data as good as the best of the available models.
16	**Runtime Characteristics**	Run execution time for typical problem (CPU or Real Time) – The model takes only a few seconds to run on a Pentium PC for a typical scenario.

Figure 3. Example of assessment of models showing the ADAM (continued).

General and Specific Characteristics for Model: ADAM

Specific Characteristics		
Part A: Source Term Submodel Type		
A1	Source Term Algorithm?	✔ YES __NO
A2	For Chemical Consequence Assessment Models	**Liquid spill:** ✔ pool evaporation __ particulate resuspension The Ille and Springer evaporation model is used. The area equals the diked area or the equilibrium area calculated by a pool-spreading formulation.
A2	For Chemical Consequence Assessment Models (Cont.)	**Pressurized releases:** ✔ two-phase jets ✔ flashing ✔ entrainment ✔ aerosol formation The thermodynamics of two-phase jets is accounted for. All unflashed liquid is assumed to remain in the cloud as an aerosol (i.e., no rain-out). Entrainment factor for a turbulent jet = 0.065. The fraction of aerosol is calculated in the flashing module. No rain-out occurs. **Solid spills:** __ resuspension __ sublimation
Part B: Dispersion Submodel Type		
B1	Gaussian	✔ Straight-line plume __Segmented plume __ Statistical plume __ Statistical puff
B2	Similarity	__ Plume ✔ Puff
Part C: Transport Submodel Type		
C2	Deterministic	ADAM is a deterministic model.
C4	Frame of Reference	✔ Eulerian __ Lagrangian __ Hybrid __ Eulerian-Lagrangian
Part D: Fire Submodel Type (Not Applicable)		
Part E: Energetic Events Submodel Type (Not Applicable)		
Part F: Health Consequence Submodel Type		
F1	For Chemical Consequence Assessment Models	**Health effects:** __ fatalities __ cancers __ latent cancers __ symptom onset **Health criteria** __ IDLH __ STEL __ TLV __ TWA __ ERPG __ TEEL __ AEGL __ WHO **Zones with flammable limits:** ✔ UFL ✔ LFL **Blast overpressure regions:** **Fire radiant energy zones:** **Risk qualification:** **Concentration:** ✔ single value __ time-history __ integrated dose **Probits:** Probits are used to compute the probability of a particular health consequence (e.g., fatality). Expressed as chemical specific probability units computed with a logarithmic probit equation.
Part G: Effects and Countermeasures Submodel Type (No Information Provided.)		
Part H: Physical Features of Model		
H2	Release Elevation	✔ ground ✔ roof
H4	Horizontal Plume Meander	Yes
H5	Horizontal/Vertical Wind Shear:	Yes
H7	Cloud Buoyancy	✔ neutral [passive] ✔ dense [negative] ✔ plume rise [positive]
H8	Cloud Liquid Droplet Formation/ Aerosolization	Yes
H9	(Radio)chemical Transformation and In-Cloud Conversion Processes	Yes

Figure 3. Example of assessment of models showing the ADAM (continued).

General and Specific Characteristics for Model: ADAM

Part I: Model Input Requirements		
I1	Radio(chemical) and Weapon Release Parameters	Release rate: ✓ Continuous ✓ Time dependent ✓ Instantaneous Release container characteristics: ✓ vapor temperature ✓ tank diameter ✓ tank height ✓ tank temperature ✓ tank pressure ✓ nozzle diameter ✓ pipe length Jet release: ✓ initial size __ shape __ concentration profile at end of jet affected zone Release dimensions: ✓ point __ line ✓ area Release elevation: ✓ ground __ roof __ stack
I2	Meteorological Parameters	Wind speed and wind direction: ✓ single point __ single tower/multiple point __ multiple towers Temperature: ✓ single point __ single tower/multiple point ✓ multiple towers See above. Dew point temperature: ✓ single point __ single tower/multiple point ✓ multiple towers Precipitation: ✓ single point __ single tower/multiple point __ multiple towers Turbulence typing parameters: __ temperature difference ✓ sigma theta __ sigma phi __ Monin-Obukhov length __ roughness length __ cloud cover __ incoming solar radiation ✓ user-specified Four dimensional meteorological fields from prognostic model: See above.
Part J: Model Output Capabilities		
J1	Hazard Zone	Concentrations are output as a function of downwind distance in a table. The area of a hazard zone is also calculated and displayed on the computer screen. Does not explicitly give concentrations at off-ceterline receptors. Computes the exposure area of the hazard zone from the specified toxic endpoint concentration value.
J2	Graphic Contours and Resolution	Yes
J4	Tabular at Fixed Downwind Locations	Yes
Part K: Model Usage Considerations (No Information Provided.)		

Figure 3. Example of assessment of models showing the ADAM (continued).

Table 1. Urban models.

Resource	No. of Models	Models Name	Reference:
Colleague: Mr. Cionco	15	CALPUFF, HIGRAD, HYPACT, *3DWF etc.	Personal communication U.S. Army Research Laboratory (ARL) Air Dispersion Model Evaluation for Rapid Assessment of Chemical Emergencies (RACE) by Crystal Franco Grad Student and Professor Wen-Whai Li Advisor University of Texas at EL Paso (UTEP)
Colleague: Dr. Michael Brown	1	* QUIC, QUIC-URB, QUIC-PLUME	Personal communication / Model Manual (Los Alamos National Laboratory) , by Eric Pardyjak, and Michael Brown, D-4
Publication Tech Report	5	DTRA HPAC/SCIPUFF VLSTRACK OMEGA etc.	"Modeling and Risk Characterization of US Demolition Operations at the Khamisiyah Pit"www.gulflink,odd,mil/khamisiyah_tech/index.htm
Software package version 4.04.	1	* From Hazard Prediction and Assessment Capability Version 4.04 (HPAC)	A Defense Threat Reduction Agency (DTRA) copy. Technology Directorate, Consequence Assessment Branch Program Manager: Mr. Ronald Meris (703-325-0608)
Journal of Applied Meteorology: Vol.43, No. 6.pp 829-846 Comparisons of Transport and Dispersion Model Predictions of URBAN 200 Field Experiment"		HPAC	General and Specific Characteristics for Model: HPAC" www.ofcm.gov/atd_dir/pdf/hpac.pdf
General and Specific Characteristics for Model: US Government Web-site	1	SCIPUFF	www.ofcm.gov/atd_dir/pdf/scipuff.pdf (DTRA – Sponsored)

Table 1. Urban models (continued).

HPAC Model Component U.S. Military Web-site		HPAC	www.dtic.mil/ndia/2005st_cbis/tuesday/smith.pdf (DTRA – Sponsored)
Product Reviews /Technical Report	100	ADASHI, ADPR, ADMS, ALOHA, BWRT, BSMR, CAMSIM, CAMEO, etc.	Prepared for the Office for Domestic Preparedness Department of Homeland Security © 2004 ThoughtLink, Inc., , (703) 281-5694, www.thoughtlink.com.
Web-site Urban Warfare Simulation	1	URWARS	The U.S. Marin Corps Chose CACI as the prime contractor in developing URWARS www.prod1.caci.com/business/systems.simulation/urwars.shtml
Colleague: Mr. Cionco	1	D2PC, D2PUFF etc.	Army/DOD models. Army Research Laboratory POC Mr. Cionco The Only Army accredited diffusion model.
Office of the Federal Coordinator for Meteorological Services and Supporting Research/ Directory of Atmospheric Transport and diffusion	5	AFTRAJ, FTAD, HYSPLIT, TRIAD, HARM II	Atmospheric Transport and Diffusion Models (NOAA/ARL/ERL) ATD Division P.O. Box 2456 Oak Rdge, TN 37831-2456 and NOAA-Air Resources Laboratory SSMC2 Room
Office of the Federal Coordinator for Meteorological Services and Supporting Research/ Directory of Atmospheric Transport and diffusion models.	1	MADICT	Army Research Office P.O.Box1221
Office of the Federal Coordinator for Coordinator for Meteorological Services and Supporting Research/ Directory of Atmospheric Transport and diffusion	3	CCSL, MESOWIND, VARYME	POC Mr. Cionco
Computational Fluid Dynamics Model/ FLUENT web-site	1	* CFD, CFD-Urban, FEFLO-Urban, FEM3MP	Laboratory for Computational Physics & Fluid Dynamics (LCP) PL Dr. William Sandberg. Navel Research Laboratory 4555 Overlook Av. SW Washington DC20375-5344 sandberg@lcp.nrl.navy.mil 202-7670526

Table 2. General models.

Storming Media Pentagon Reports	1	WADOCT	An Atmospheric Dispersion Model for Complex Terrain Authors: Bruce A. Kunkel; Yutaka Izumi; Geophysics Laboratory (AFSC) HANSCOM AFB MA www.stormingmedia.us/02/0299/A029922.html
Storming Media Pentagon Reports	1	AFWIND	A surface-layer windflow model: Bruce A. Kunkel; Yutaka Izumi; Geophysics Laboratory (AFSC) HANSCOM AFB MA www.stormingmedia.us/02/0299/A029922.html
Storming Media Pentagon Reports	1	AFTOX	A Gaussian puff dispersion model: Bruce A. Kunkel; Yutaka Izumi; Geophysics Laboratory (AFSC) HANSCOM AFB MA www.stormingmedia.us/02/0299/A029922.html
Web-site: U.S Environmental Protection Agency/ A Technology Transfer Network support Center for Regulatory Atmospheric Modeling	1	AERMOD / ISC-AERMOD, AERMAP, AERSURFACE, BPIP, BPIPPRM, CALMPRO, CHAVG, CONCOR, and EMS-HAP	A steady-state plume model that incorporates air dispersion based on planetary boundary layer turbulence structure & scaling concepts, including treatment of both surface and elevate sources and both simple and complex terrain. www.epa.gov/scram001/dispersion_prefrec.htm Also www.chempute.com/iscaermodpro.htm

6. Lessons Learned

Documentation must be done with the users in mind. If the summaries and the model surveys are not made user friendly and accessible, then researchers or modelers will take another path to get what they need. Doing this can be time consuming and may hinder the decision making of researchers and modelers. The material can be excellent and the data limited in functionality. In short, this summary and model survey has proven to be good, if not the best, method of side-by-side comparison of models.

7. Conclusions

After considering the relevant facts, we propose that a follow-on effort would be worthwhile. Creating a flat database model that pairs a review of models with an assessment of models is the best method for providing model information to researchers both within and outside of ARL. Though time consuming and expensive, an automated flat database model project could be established in such a way that would allow more researchers to have access to the information they need in an easy-to-use, updatable form.

Acronyms

ADAM	Air Force Dispersion Assessment model
ADASHI	Automated Decision Aid for Hazardous Incidents
ARL	U.S. Army Research Laboratory
BE	Battlefield Environment
ITA	Innovative Technology Application
OFCM	Office of the Federal Coordinator for Meteorological Services and Supporting Research
WSMR	White Sands Missile Range

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